

**REMARKS**

Claims 8, 12, 15, 18, 21, and 24 are pending in this application. By this Supplemental Amendment, new claim 24 is added. Support for new claim 24 may be found, for example, in the specification, at page 26, line 9 to page 28, line 9. No new matter is added.

In view of the May 7, 2009 Amendment, and further in view of the foregoing amendments and following remarks, reconsideration and allowance of the application are respectfully requested.

**I. Rejections Under 35 U.S.C. §103****A. Ono and Sakurada**

The Office Action rejects claims 8, 12, 15, and 21 under 35 U.S.C. §103(a) over U.S. Patent Application Publication No. 2002/0017234 to Ono et al. ("Ono") in view of U.S. Patent Application Publication No. 2003/0116082 to Sakurada et al. ("Sakurada"). The rejection is respectfully traversed.

Claim 8 recites, *inter alia*, "A method for producing a single crystal by pulling a single crystal from a raw material melt in a chamber in accordance with Czochralski method ... wherein the pulling of the single crystal is performed with being controlled by arranging at least a cooling cylinder to be forced cooled with a cooling medium and an auxiliary member for cooling in the chamber so that an average of cooling rate in passing through a temperature region of the melt point of the single crystal to 950 °C is in the range of 0.96 °C/min or more and so that an average of cooling rate in passing through a temperature region of 1150 °C to 1080 °C is in the range of 0.88 °C/min or more and so that an average of cooling rate in passing through a temperature region of 1050 °C to 950 °C is in the range of 0.71 °C/min or more, and thereby preventing aggregation of point defects, and wherein a growth rate margin for pulling the single crystal having a defect-free region (an upper limit of the growth rate – a lower limit of the growth rate) is in the range of 7% or more of a growth rate average of the

single crystal ((the upper limit of the growth rate + the lower limit of the growth rate) ÷ 2)."

Applicants respectfully assert that Ono and Sakurada, either alone or in combination, would not have rendered obvious at least the above features of claim 8.

The Office Action asserts that the cooling rates disclosed in Ono overlap the cooling rates of the claimed method, thus allegedly rendering the claimed cooling rates obvious. See Office Action, page 3. A *prima facie* case of obviousness based upon overlapping ranges can be rebutted by showing "that the claimed range achieves unexpected results relative to the prior art range." MPEP §2144.05.

The cooling rates as recited in claim 8 achieve unexpected results that cannot be achieved with the method disclosed in Ono. These discrepancies are not cured by Sakurada. These unexpected results establish non-obviousness of the claimed method.

As shown by Examples 1 and 2 of the specification, the claimed method prevents the aggregation of point defects and enlarges the production margin of a defect-free region in which secondary defects that are aggregates of the point defects are not detected. See specification, page 23, line 18 - page 28, line 9.

Example 1 demonstrates the unexpected results achieved by controlling the average of the cooling rate in passing through each of: a temperature region of the melt point of the single crystal to 950°C, a temperature region of 1150°C to 1080°C, and a temperature region of 1050°C to 950°C to be about: 1.31°C/min, 1.35°C/min, and 1.21°C/min, respectively. Example 2 demonstrates the unexpected results achieved by controlling the average of the cooling rate in passing through each of: a temperature region of the melt point of the single crystal to 950°C, a temperature region of 1150°C to 1080°C, and a temperature region of 1050°C to 950°C to be about: 1.64°C/min, 1.56°C/min, and 1.56°C/min, respectively. See specification, page 24, line 12 - page 26, line 7, and page 27, line 3 - page 28, line 9.

In contrast, in Comparative Examples 1 and 2 a silicon single crystal was grown using a single crystal-producing apparatus having no cooling cylinder, and thus no means of controlling the cooling rate. Comparative Example 1 resulted in average cooling rates in passing through each of: a temperature region of the melt point of the single crystal to 950°C, a temperature region of 1150°C to 1080°C, and a temperature region of 1050°C to 950°C to be about: 0.64°C/min, 0.58°C/min, and 0.43°C/min, respectively. Comparative Example 2 resulted in average cooling rates in passing through each of: a temperature region of the melt point of the single crystal to 950°C, a temperature region of 1150°C to 1080°C, and a temperature region of 1050°C to 950°C to be about: 0.84°C/min, 0.72°C/min, and 0.59°C/min, respectively. In the Comparative Examples, crystals were grown with secondary defects generated over the whole length of the straight body. Additionally, the production margin of the single crystal having a defect-free region was very small. See specification, page 28, line 11 - page 31, line 15.

The method of Ono merely discloses a cooling rate of not less than 7.3°C/min in the temperature range of 1200-1050°C, and a cooling rate of not more than 3.5°C/min in the temperature range of 1000-700°C. See Ono, paragraph [0031]. However, as shown by Comparative Examples 1 and 2 in the specification, where the average cooling rates are outside of the claimed ranges, but within the range disclosed in Ono, (i.e., not more than 3.5°C/min), defect-free crystals in which no secondary defects were generated could not be grown. Additionally, the production margin of the single crystal having a defect-free region could not be enlarged.

In view of the above data, Applicants respectfully assert that the claimed temperature ranges and corresponding cooling rates achieve improved and unexpected results relative to the temperature ranges and corresponding cooling rates disclosed in Ono. Thus, the claimed method would not have been rendered obvious by Ono.

Further, Sakurada merely discloses a method in which a crystal is grown in a defect-free region, which is an N region, on the outside of OSF in which a defect region, as detected by copper deposition, does not exist. Sakurada does not disclose or provide any reason or rationale for one of ordinary skill in the art to have controlled the average cooling rate passing through the three temperature regions as claimed, or that pulling up of a single crystal within the three claimed temperature regions at the three claimed cooling rates would result in an enlarged V/G value that falls within a defect-free zone. Furthermore, Sakurada does not disclose or provide any reason or rationale for one of ordinary skill in the art to have been aware that controlling the average cooling rates within the three claimed temperature regions could or would prevent aggregation of point defects, or increase the production margin of a defect-free region in which secondary defects that are aggregates of the point defects are not detected. Accordingly, Applicants respectfully assert that Sakurada does not address the above discrepancies of Ono as to claim 8. Therefore, Ono and Sakurada, either alone or in combination, would not have rendered obvious each and every feature of claim 8.

Claim 8 would not have been rendered obvious by Ono and Sakurada, either alone or in combination. Claims 12, 15 and 21 depend from claim 8 and, thus, also would not have been rendered obvious by Ono and Sakurada, either alone or in combination. Accordingly, reconsideration and withdrawal of the rejection are respectfully requested.

**B. Ono, Sakurada and Iino**

The Office Action rejects claim 18 under 35 U.S.C. §103(a) over Ono in view of Sakurada and further in view of U.S. Patent No. 5,980,630 to Iino et al. ("Iino"). Applicants respectfully traverse the rejection.

For at least the reasons stated above, Ono and Sakurada would not have rendered obvious each and every feature of claim 8. The Office Action merely applies Iino as disclosing employing a magnetic field in the growth of single crystalline ingot materials.

Therefore, Iino is not applied to address the above discrepancies of Ono and Sakurada. Thus, Ono, Sakurada and Iino, individually or in combination, would not have rendered obvious each and every feature of claim 8.

Claim 8 would not have been rendered obvious by Ono, Sakurada and Iino, individually or in combination. Claim 18 depends from claim 8 and, thus, also would not have been rendered obvious by Ono, Sakurada and Iino, individually or in combination. Accordingly, reconsideration and withdrawal of the rejection are respectfully requested.

## II. New Claim

By this Amendment, new claim 24 is presented. New claim 24 depends from claim 8 and, thus, distinguishes over the applied references for at least the reasons discussed above with respect to claim 8, as well as for the additional features that it recites.

New claim 24 is further patentable over the applied references. New claim 24 recites, *inter alia*, "... the average of cooling rate in passing through the temperature region of the melt point of the single crystal to 950 °C is in the range of 0.96 °C/min to 1.64 °C/min and so that the average of cooling rate in passing through the temperature region of 1150 °C to 1080 °C is in the range of 0.88 °C/min to 1.56 °C/min and so that the average of cooling rate in passing through the temperature region of 1050 °C to 950 °C is in the range of 0.71 °C/min to 1.56 °C/min."

In contrast, the method of Ono, which the Office Action relies upon as allegedly disclosing the claimed temperature ranges and cooling rates, discloses a cooling rate of not less than 7.3°C/min in the temperature range of 1200-1050°C, which is well outside of the range of new claim 24. Further, Applicants respectfully assert that it would not have been obvious to one having ordinary skill in the art to have modified the disclosure of Ono to be within the ranges as recited in new claim 24. Prompt examination and allowance of new claim 24 is respectfully requested.

**III. Conclusion**

In view of the foregoing, it is respectfully submitted that this application is in condition for allowance. Favorable reconsideration and prompt allowance of the application are earnestly solicited.

Should the Examiner believe that anything further would be desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact the undersigned at the telephone number set forth below.

Respectfully submitted,



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